Evaluation of Virtual Environment Navigation

Background

- Synergistically brings together the fields of *virtual environments* and *usability engineering*
- Conducting a series of usability studies of *Dragon*, a battlefield visualization system developed at NRL.
- Collaboration between Prof. Deborah Hix (Virginia Tech) and Dr. Ed Swan (NRL)

Objective

Meta Level, Research-Centered:

- Identify *general principals* and *most important parameters* of VR user interface design
- Identify *effective techniques* for VR usability engineering

Basic Level, System-Centered:

- Design a usable Dragon interface
- Evaluate and iteratively improve Dragon user interface

Accomplishments FY00/Milestones FY01

- Ran a series of *heuristic* and *formative* evaluation studies of Dragon.
- Developed the seminal usability evaluation methodology for VR; report on this won ***best paper award*** at IEEE VR 1999.
- Currently running a *summative* study of VR navigation techniques in Dragon

Evaluation Methodology

- **Developed and refined the seminal evaluation methodology for virtual reality**
  - **In collaboration with Dr. Deborah Hix of Virginia Tech [Hix funded by ONR-342 (Gigley)]**

- **Methodology involves three levels of evaluation:**
  1. *Expert Heuristic Evaluation:* **assessment by user interface design experts, to determine violated usability design guidelines**
  2. *User Scenario Evaluation:* **assessment with users, to iteratively determine and improve usability**
     - **Follow formal task scenario**
     - **Collect both *quantitative* and *qualitative* data**
  3. *Comparative Evaluation:* **assessment with users, to determine which among several design alternatives is "best"**
     - **Classical n x m experimental design**

Application of Methodology

	cost	generality	precision
	low	general	low
Expert Heuristic Evaluation	↑	↑	↑
User Scenario Evaluation	↓	↓	↓
Comparative Evaluation	high	specific	high
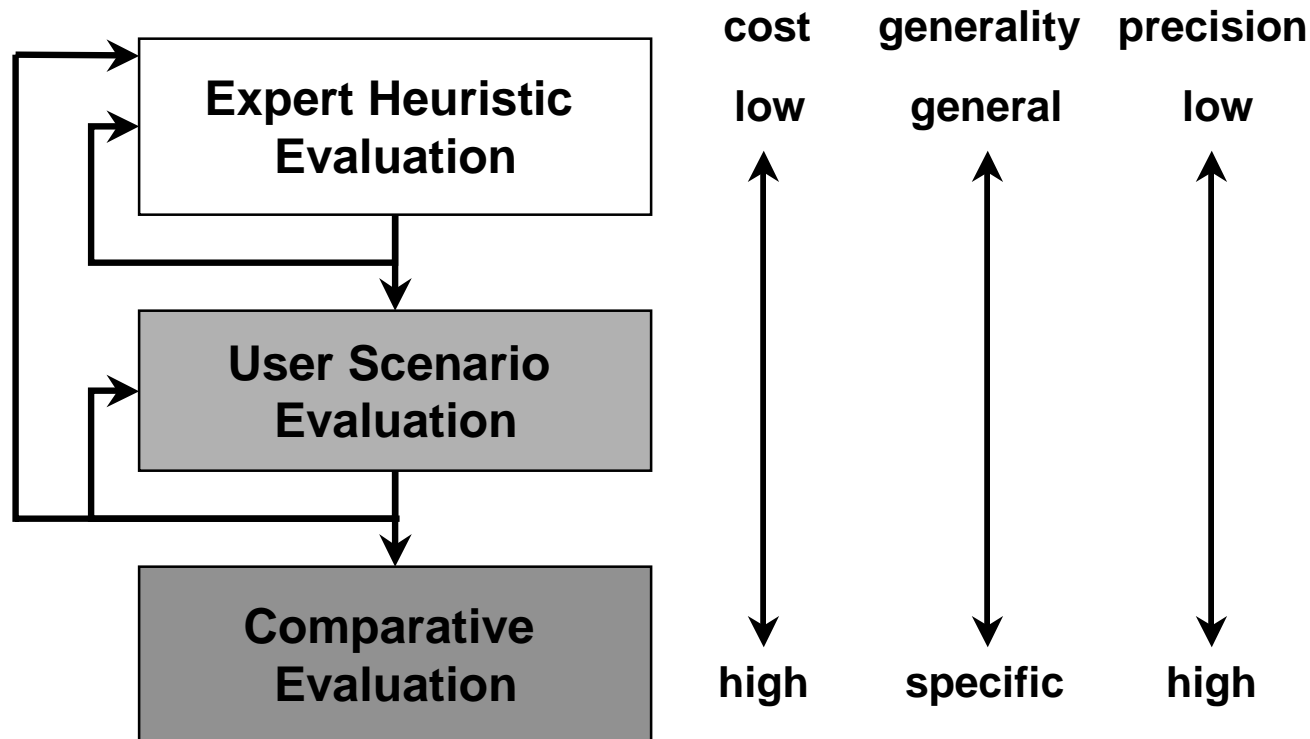
- *Heuristic* and *user scenario* iteration ensures designs with equivalent usability, allowing meaningful *comparative* evaluation

Accomplishments

- **Before Spring 99:**
    - *Expert heuristic* evaluations of IVRS user interface
    - Focus on navigation
    - *Expert heuristic* and *user scenario* evaluations of all navigational variables

- **New:**
    - Finished usability evaluation methodology
    - Currently running *comparative* evaluation of 4 navigational variables
        - Goal: systematic examination of variables with greatest influence on IVRS navigation performance
        - Expected result: which levels of variables result in best navigation performance with IVRS system

Comparative Navigation Study

			on				off			
Between Subject	**Stereo Viewing**		on				off			
	Control Movement		rate		position		rate		position	
	Frame of Reference		ego	exo	ego	exo	ego	exo	ego	exo
Within Subject	**Computer Platform**	*GROTTO*	subjects 1 – 4	subjects 5 – 8	subjects 9 – 12	subjects 13 – 16	subjects 17 – 20	subjects 21 – 24	subjects 25 – 28	subjects 29 – 32
		wall								
		workbench								
		desktop								

- **Studying 4 variables with greatest impact on navigation performance**
  - Chosen from initial list of 27 variables
  - Narrowed list with subject observation, taxonomy comparison, literature review, list-making, brainstorming

Impact on Field

- **Seminal usability evaluation methodology for VR**
  - *Evaluating* and *iteratively refining* **VR user interaction**

- **Hix, Swan, Gabbard, McGee, Durbin, King, "User-Centered Design and Evaluation of a Real-Time Battlefield Visualization Virtual Environment", Proceedings *IEEE Virtual Reality '99*.**
  - **Won *best paper award* at IEEE Virtual Reality '99.**
  - **"I had more learning per hour from this paper than at any time in the past 6 months."   — Fredrick P. Brooks, VR '99**

- **Gabbard, Hix, Swan, "User-Centered Design and Evaluation of Virtual Environments", *IEEE Computer Graphics and Applications*, Volume 19, Number 6, November / December, 1999, pages 51–59.**
  - *Invited paper*